1   **HYPOCYCLOID REDUCING APPARATUS**

2   <u>BACKGROUND OF THE INVENTION</u>

3   1. Field of the Invention

4   The present invention relates to a revolution reducing apparatus, and

5   more particularly to hypocycloid reducing apparatus that is quiet and compact.

6   2. Description of Related Art

7   Reducing gears, also called reducers are typically coupled to motors for

8   reducing revolution speeds of the motors. The reducers are widely used in many

9   engineering designs. However, the reducers today are generally applied to gears,

10   such as planetary gears to achieve a purpose of reducing revolutions of a rotating

11   shaft. Although, the reducing gears can change the speed of rotation to a required

12   speed of rotation for the rotating shaft, noises will be generated during a period

13   of the gear operating. Besides, as an arrangement of the gears in the gear reducer

14   always occupies a huge space, the gear reducer will be bulky.

15   A hypocycloid reducing apparatus works as a speed reduction and

16   torque multiplier mechanism that is quiet, compact and durable. However, a

17   hypocycloid reducing apparatus is not widely used in engineering designs

18   because few mechanical engineers understand the design principle of the

19   hypocycloid reducing apparatus.

20   To overcome the shortcomings, the present invention provides a

21   hypocycloid reducing apparatus to mitigate or obviate the aforementioned

22   problems.

23   <u>SUMMARY OF THE INVENTION</u>

24   The main objective of the invention is to provide a hypocycloid reducing

1   apparatus operating as a speed reduction and torque multiplier mechanism,

2   wherein the hypocycloid reducing apparatus is quiet, compact and durable.

3   Other objectives, advantages and novel features of the invention will

4   become more apparent from the following detailed description when taken in

5   conjunction with the accompanying drawings.

6   BRIEF DESCRIPTION OF THE DRAWINGS

7   Fig. 1 is an exploded perspective view of a hypocycloid reducing

8   apparatus in accordance with the present invention;

9   Fig. 2 is an operational cross sectional plan view of the hypocycloid

10   reducing apparatus in Fig. 1 at rest;

11   Fig. 3 is a cross sectional view of the hypocycloid reducing apparatus

12   along 3-3 line in Fig. 2;

13   Fig. 4 is an operational cross sectional plan view of the hypocycloid

14   reducing apparatus in Fig. 1 wherein the hypocycloid reducing apparatus is

15   mounted in a stationary base and is operating;

16   Fig. 5 is a cross sectional view of the hypocycloid reducing apparatus

17   along 5-5 line in Fig. 4;

18   Fig. 6 is an operational cross sectional plan view of the hypocycloid

19   reducing apparatus in Fig. 1 wherein the hypocycloid reducing apparatus is

20   mounted in a wheel hub to drive a wheel;

21   Fig. 7 is a cross sectional view of the hypocycloid reducing apparatus

22   along 7-7 line in Fig. 6 at rest;

23   Fig. 8 is an operational cross sectional plan view of the hypocycloid

24   reducing apparatus in Fig. 6 wherein the hypocycloid reducing apparatus is

1 operated; and

2   Fig. 9 is a cross sectional view of the hypocycloid reducing apparatus

3 along 9-9 line in Fig. 8.

4 DETAILED DESCRIPTION OF PREFERRED EMBODIMENT

5   With reference to Figs. 1 to 3, a hypocycloid reducing apparatus in

6 accordance with the present invention is connected to a rotating mechanism,

7 such as a motor (50) having a driving shaft (51), to reduce a speed of revolutions

8 of the motor driving shaft (51). The hypocycloid reducing apparatus comprises a

9 driven input (10), an inside bracket (20), an outside bracket (30) and multiple

10 bearings (40) including a one-directional bearing (14). One of the inside bracket

11 (20) and the outside bracket (30) is stationary, and the other is rotatable. For

12 convenient illustrating purpose only, the inside bracket (20) is rotatable and the

13 outside bracket (30) is stationary in the following description.

14   The driven input (10) is coupled to the driving shaft (51) of the motor

15 (50) and is rotated by the driving shaft (51). The driven input (10) has a proximal

16 end (not numbered), a distal end (not numbered), an off-center assembly (not

17 numbered), a blind hole (13) and a pivot shaft (111). The off-center assembly

18 comprises first and second off-center members (11, 12) that are circular and

19 located in opposite to provide a dynamic balancing to the driven input (10) as the

20 driven input (10) is rotated, and a first actuating bearing (42) and a second

21 actuating bearing (41) that are respectively mounted on the first and the second

22 off-center members (11, 12). The blind hole (13) is defined in the distal end of

23 the driven input (10) to mount and hold the one-direction bearing (14) that is

24 coupled to the driving shaft (51). Therefore, the driving shaft (51) only can rotate

1   the driven input (10) in a given direction, and the one-directional bearing (14)

2   will prevent the motor driving shaft (51) from being rotated in a reverse direction

3   related to the given direction.

4   The driven input (10) is rotatably mounted in and held in the inside

5   bracket (20) that is hollow and fitted with a bearing (43). The inside bracket (20)

6   has a proximal end (not numbered), a distal end (not numbered), an inner space

7   (211), an annular lip (212), multiple through holes (213), a bearing journal (214)

8   and an output shaft (215). The inner space (211) is defined in the distal end of the

9   inside bracket (20) to hold the driven input (10) with the bearings (41, 42, 43).

10 The annular lip (212) is formed radially outward at the distal end of the inside

11 bracket (20) and abuts rotatably the outside bracket (30). The through holes (213)

12 are rectangular when viewed face on, are arranged into an annular arrangement

13 including first and second annular configurations that are complementary and

14 are aligned respectively with the first actuating bearing (42) and the second

15 actuating bearing (41). Each through hole (213) receives an actuating roller, such

16 as a cylinder (22) mounted rotatably in the through hole (213). The first and the

17 second actuating bearings (42, 41) are respectively going to press sequentially

18 one cylinder (22) in a corresponding of through holes (213) for an instant while

19 the driven input (10) is rotated. The bearing journal (214) is formed near the

20 proximal end of the inside bracket (20) to mount a bearing (44). The output shaft

21 (215) is attached to the proximal end of the inside bracket (20).

22   The outside bracket (30) is hollow and has a passage (311) to mount

23 co-axially the rotatable inside bracket (20). The outside bracket (30) further has a

24 distal end (not numbered), a proximal end (not numbered), an interior periphery

4

1   (not numbered) with multiple lobe grooves (312) and an annular bearing groove

2   (313) formed near the proximal end of the outside bracket (30). The output shaft

3   (215) extends out of the passage (311) through the proximal end of the outside

4   bracket (30). The bearing (44) is mounted on the bearing journal (214) and is

5   held in the annular bearing groove (313) to hold rotatably the inside bracket (20)

6   in position.

7   Consequently, when the driven input (10) is rotated by the motor driving

8   shaft (51) about a fixed axis of rotation, the actuating bearings (41, 42) that are

9   respectively mounted on the off-center members (11, 12) will be rotated by the

10   rotating driven input (10). Since the off-center members (11, 12) are not

11   concentric and are located in opposite, the rotation of all the driven input (10) is

12   dynamically balanced. The actuating bearings (42, 41) will encounter

13   sequentially with one cylinder (22) in the through holes (213) at a time. The

14   actuated cylinder (22) will be pressed sequentially to encounter with one of the

15   lobe grooves (312) that will cause a reaction force to the cylinder (22) to rotate

16   the inside bracket (20) about an axis of revolution. The actuating bearings (42,

17   41) will also diminish frictions during the actuating bearings (42, 41)

18   encountering with the cylinders (22).

19   A speed reduction ratio can be calculated by a function of quantities of

20   the cylinders (22) in one annular configuration and the lobe grooves (312).

21   Supposing that M represents a quantity of the lobe grooves (312) and N

22   represents a quantity of the cylinders (22) of each annular configuration, the

23   speed reduction ration can be calculated by a fraction of a function of N and M,

24   wherein the quantity of N is fewer than the quantity of M. In an optimized

1   condition, the quantity of N is one fewer than the quantity of M.

2   Consequently, in Figs. 1, 4 and 5, the outside bracket (30) is fixed on a

3   stationary base (60), and the quantity of N is equal to 19 and the quantity of M is

4   equal to 20. Thus, the resultant speed reduction ratio is calculated to be −19. The

5   negative sign signifies that the input and out output rotations are in opposite

6   directions. In other words, revolutions of the driven input (10) are regarded as an

7   input rotation and revolutions of the inside bracket (20) are regarded as an output

8   rotation. The driven input (10) that is rotated by the motor driving shaft (51)

9   rotates the inside bracket (20) in a direction opposite to the rotation of the driven

10   input (10) at one-nineteenth the angular movement of the driven input (10). The

11   output speed of revolution to the inside bracket (20) is reduced by the

12   hypocycloid reducing apparatus.

13   With reference to Figs. 6 and 7, an opposite condition is shown in that

14   the inside bracket (20) is stationary, the outside bracket (30) is rotatable and the

15   hypocycloid reducing apparatus is applied to drive a motorized bicycle (not

16   shown) and is mounted in a wheel hub (70). In such a state, the output shaft (215)

17   is adapted to be mounted securely on a fork (not shown) of the bicycle and is

18   fixed. The outside bracket (30) is clamped by four ribs (71) of the wheel hub (70)

19   to drive the wheel hub (70) to rotate.

20   With reference to Figs. 8 and 9, when the motor (50) starts to rotate the

21   driving shaft (51) that rotates simultaneously the driven input (10) with the first

22   and the second actuating bearings (42, 41), the two actuating bearings (41, 42)

23   will encounter respectively one different cylinder (22) in sequence. Since the

24   inside bracket (20) is fixed, the outside bracket (30) will be rotated with a

1 reduced speed of rotation to drive the wheel hub (70) that will rotate a wheel (not
2 shown) to move the bicycle.

3   Also, since the one-directional bearing (14) is mounted between the
4 motor driving shaft (51) and the driven input (10), the one-directional bearing
5 (14) will prevent the motor (50) from being reversed when the bicycle is moved
6 physically by the rider, that is, turning the pedals of the bicycle. Thus, the one-
7 directional bearing (14) prevents possible damage to the motor (50) that might
8 otherwise be caused by reverse rotation of the driving shaft (51).

9   Because all parts of the hypocycloid reducing apparatus in accordance
10 with the present invention are arrange co-axially about a given axis, a size of the
11 whole hypocycloid reducing apparatus is compact. Power transmission in the
12 hypocycloid reducing apparatus is by means of the actuating bearings (41, 42)
13 and the cylinders (22) so that the hypocycloid reducing apparatus is quiet during
14 a period of operation.

15   Even though numerous characteristics and advantages of the present
16 invention have been set forth in the foregoing description, together with details
17 of the structure and function of the invention, the disclosure is illustrative only,
18 and changes may be made in detail, especially in matters of shape, size, and
19 arrangement of parts within the scope of the appended claims.